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THE WAYS TO IMPROVE THE EFFICIENCY OF MOBILE SOLAR DRYERS

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ABSTRACT

This paper presents ways to improve the efficiency of mobile solar dryers: the efficiency of heated air due to the heat storage capacity of the solar collector, natural convection of the heated air duct and the method of positioning pallets in the drying cabinet for uniform flow of heated agricultural pallets. Dried fruit production in farms of predominantly agrarian countries is based on natural air-sun drying. Exposure to dust, dew, ingress of impurities and direct sunlight, as well as the presence of insects and rodents reduces the quality of the product and requires additional factory processing. The use of solar dryers, although it was a definite step towards eliminating these shortcomings, still depends on their design. Studies have proven the reality of combining the benefits of artificial and natural drying by creating combined solar-fuel dryers. They allow you to realize the benefits of solar and artificial methods of drying, by creating compact, transportable, cheap and less energy-intensive drying systems.

KEYWORDS: Solar Collector, Heated Air Duct, Convection, Heated Air Turbulization & Pallets

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Original Article

INTRODUCTION

A wide range of solar dryers have been designed and built in different regions of the world. Solar dryers differ in their capabilities: ***direct***, ***indirect*** and ***offset*** and in degrees of technical characteristics.

Indirect Solar Dryers are often referred to as distributed type solar dryers. Here, the plant is located in trays or shelves inside a closed, opaque drying chamber and is heated by circulating air heated during its flow through the solar collector (Ekechukwu OV, Norton B (1999) Review of solar energy drying systems II an over view of solar drying technology. Energy Convers Manag 40:615–655).

Since the culture is not exposed to direct solar radiation, this method reduces discoloration and cracking on the surface of the culture (Sharma A, Chen CR, Vu Lan N (2009) Solar-energy drying systems: a review. Renew SustEnerg Rev 13: 1185– 1210). Thus, they are recommended for relatively sensitive foods, such as herbs, spices, and fruits, where the direct effects of solar radiation will adversely affect vitamin C levels.

Combined Solar Dryers mixed mode (SU1281844, Ekechukwu and Norton 1999, VijayaVenkata Raman et al., 2012) combine the functions of direct (integral) type and indirect (distributed) types of solar dryers. For the drying process, a combination of radial solar radiation incident on the product and preheated air in the solar collector is used.

A retrospective analysis of the available literature shows that the following drawbacks are often observed: there is a lack of design data (A compare is on between natural and solar drying of banana chips and chilly drying using smooth and artificially rougheried rougheried absorber plate in solar air heater. J.L. Bhagoria, Sanjeev Kumar Yadav. IJMPERD, ISSEN(P): 2249-6890$ ISSN(E): 2249-8001 Vol. 9, Issue 1, Feb. 2019, 51–58) and the heat capacity of solar collectors, the structure of the duct determining the efficiency of natural convection and turbulization of heated air as well as the location of pallets for drying agricultural products providing uniform flow preheated air and uniform temperature distribution.

As a result, the following disadvantages of solar drying devices are observed:

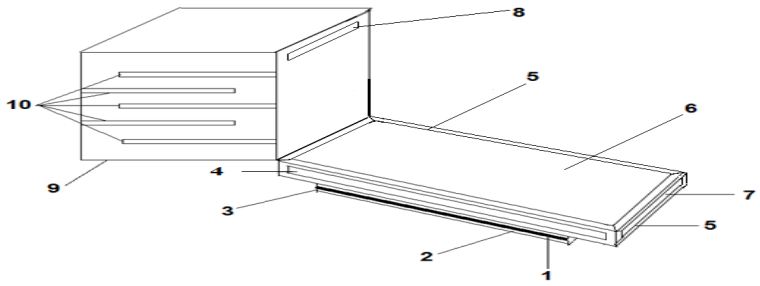
- When sucking fresh air under the heat absorbing panel (Usmanov B. Sh., KushievKh. Kh, Nuriev K K, Rakhmatov O., Yusupov A. M. Heli-dryer. Patent UZ FAP 01106 of 06/30/2016 Bulletin № 6.5. c.), natural convection does not occur, the desired air heating is not achieved and the air heating efficiency will be negligible;
- Heat-absorbing nozzle, made in the form of a cellular metal thin panel and not having sufficient bulk density (UsmanovB. Sh., KushievKh. Kh., Nuriev KK, Rakhmatov O., Yusupov A.M.Heli-dryer. Patent UZ FAP 01106 of 06/30/2016 Bulletin № 6.5.c.), does not provide high heat absorption efficiency and achieve the difference between the density of heated air and the environment, since the amount of absorbed solar energy is directly proportional to the specific heat and collector mass $dQ = C_{\mu}mdT$;
- The lack of effective thermal insulation from the bottom of the heat-absorbing panel reduces the heat absorption coefficient;
- The use of pallets equally located on the floors in the presence of agricultural products with different fractions does not provide sufficient turbulence in the heated air and uniform distribution of the heated air or temperature throughout the height of the drying cabinet.

Main Part

Ways to Improve the Efficiency of Convection of Incoming Air

To improve the efficiency of air heating, it is necessary to create a structural solution to ensure the natural convection of cold air. To achieve natural air convection and create a greenhouse regime, increase the height of the air duct; the air duct must be installed above the upper part of the heat-absorbing panel - the solar collector.

Picture 1 shows a general view of a solar drying installation.



1 - Solar Collector, 2 - Heat Insulating Coating, 3 - Solar Collector Body, 4 - Duct - Heated Air, 5 - Duct Frame, 6 - Optical Transparent Film, 7 - Air Inlet, 8 - Used Air Outlet, 9 - Nestilny Cabinet, 10 - Pallets

Figure 1: Solar Drying Installation

The installation of the air duct above the solar collector provides natural convection of the incoming air into the gravity field with uneven heating along the height of the air duct.

It should be noted that under convection heat transfer in liquids and gases is called matter flows. Natural (free) convection occurs in the field of gravity with uneven heating (heating from the bottom) of the flowing substances. The heated substance under the action of the Archimedean force $F_A = \Delta_l g V$(Δ_l- is the difference between the density of heated air and the environment, ***V***- is its volume, ***g***- is the acceleration of free fall) moves relative to the less heated substance in the opposite direction to the force of gravity. Convection tends to equalize the temperature of the substance. With a stationary supply of heat to a substance, stationary convection currents arise in it. The intensity of convection depends on the temperature difference between the layers, thermal conductivity and viscosity of the medium.

Ways to Increase the Heat Absorption Efficiency of the Solar Collector

To increase the efficiency of heat absorption, it is necessary to increase the density and mass of the heat-absorbing panel and also provide for the thermal insulation of the solar collector from the external environment.

Picture 2. shows a solar collector panel made of solid, blackened profiled aluminum sheet with integrated tubes, which has an absorption capacity of solar radiation from 0.85 to 0.95. The size of the solar collector is 1880x1230x50 mm, eight parallel-embedded pipes with a diameter of 25 mm have a total displacement of 10 liters and increase the heat capacity of the heated air. Thermal insulation of the lower part of the panel and low thermal conductivity of the side walls of the air duct contribute to an increase in the efficiency of heat absorption and an increase in the temperature of the heated air.

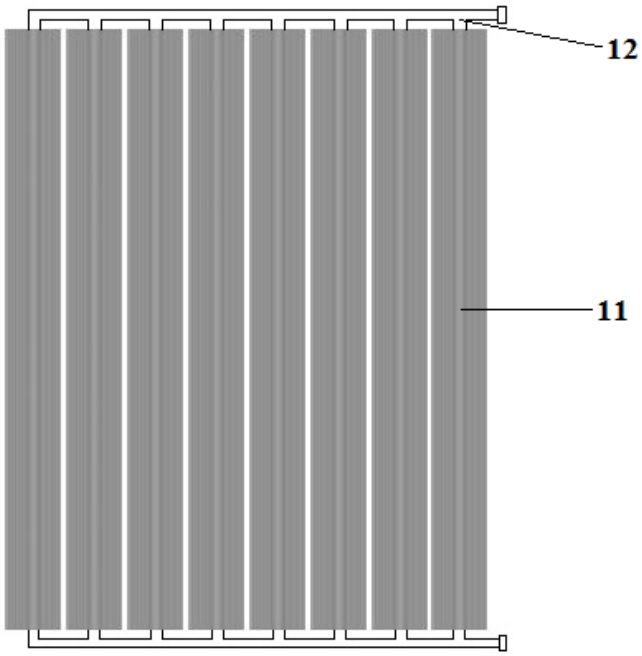


Figure 2: Solar Collector Panel 11 - Solid, Blackened Aluminum Sheet, 12 - Stainless Steel Pipe (Diameter 25 mm)

Ways to Increase the Turbulence of the Preheated Air and Achieve Uniform Temperature Distribution in the Pallets, Multi-Storey-Located in the Drying Cabinet

Fresh air enters the surface of the solar collector and is heated. Thermal insulation of the lower part of the panel and the presence of embedded aluminum pipes filled with water contribute to an increase in the efficiency of heat absorption. The high duct height (0.25 m) has a greenhouse heating mechanism that ensures high efficiency of air heating. The low thermal conductivity of the side portions of the duct increases the temperature of the heated air. The heated air enters the inlet of the drying cabinet. Offset pallets from each other at a certain distance across the floors of the drying cabinet provides a uniform flow (turbulization) of heated air and free flow around pallets located on different floors.

CONCLUSIONS

We have proposed ways to increase the efficiency of increasing the heat absorption of a solar collector, natural convection of heated air, the use of the greenhouse duct mechanism and the method of free flow of heated air pallets to accommodate agricultural products.

The heat-absorbing panel of the drying unit, made of solid, blackened profiled aluminum sheet with integrated pipes, provides high heat absorption efficiency, has an absorption capacity for solar radiation from 0,89 to 0,94. Built-in pipes can contain water with a volume of about 10 liters and increase the heat capacity of the heated air. Thermal insulation of the lower part of the panel helps to increase the efficiency of heat absorption. The high duct height above the solar collector provides the greenhouse heating mechanism, provides natural air convection and high efficiency of air heating. The low thermal conductivity of the side of the air duct lowers the temperature of the heated air. Offset pallets from each other on the floors of the drying cabinet provides free flow of dried products on pallets and a uniform flow of heated air.

In general, a prototype solar drying installation has the following technical characteristics:

- The solar collector panel is blackened one-piece profiled aluminum sheet with a thickness of 3 mm, size 188x1230mm^2, with an area of 2,31 m^2.
- Absorption efficiency of solar radiation collector – 0,92%.
- Built-in pipes - eight-channel, with a diameter of 25 mm, height of 1,88 m with a total displacement of 10 liters.
- Duct height - 25 mm.
- The dimensions of the drying cabinet are 1,23x1.72x0.75m with a total volume of 1.58 m3.
- The area of pallets - 0,90 m^2.
- Number of pallets - 6 pcs.
- The average temperature inside the drying cabinet at 30 °C ambient temperature is 74 - 78 °C and the relative humidity was about 10%.

Below are the external views of a prototype solar drying installation, a drying cabinet and the location of the pallets.

Figure 3: Prototype Solar Drying Installation

Figure 4: Location of Pallets for Drying Agricultural Products

REFERENCES

1. *Ekechukwu OV, Norton B (1999) Review of solar-energy drying systems II an overview of solar drying technology. Energy Convers Manag 40:615–655.*
2. *Sharma A, Chen CR, Vu Lan N (2009) Solar-energy drying systems: a review. Renew SustEnerg Rev 13:1185–1210.*
3. *SU1281844, Ekechukwu and Norton 1999, Vijaya Venkata Raman et al., 2012.*
4. *Senthil, R. A. M. A. L. I. N. G. A. M., Gupta, M. U. K. U. N. D., & Rath, C. H. I. N. M. A. Y. A. (2017). Parametric analysis of a concentrated solar receiver with Scheffler reflector. Int J Mech Prod Eng Res Dev, 7(5), 261-268.*
5. *A comparison between natural and solar drying of banana chips and chilly drying using smooth and artificially rougheried rougheried absorber plate in solar air heater. J.L. Bhagoria, Sanjeev Kumar Yadav. IJMPERD, ISSEN (P): 2249-6890$ ISSN(E): 2249-8001 Vol.9, Issue 1, Feb.2019, 51-58.*
6. *УсмановБ. Ш., Кушиев Х.Х., Нуриев К.К., Рахматов О., Юсупов А.М. Гелиосушилка. Патент UZFAP 01106 от 30.06.2016 Бюллетень № 6.5.с.*